THE ACADIAN TRIASSIC

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PART III

STRUCTURE OF THE ACADIAN TRIASSIC

The Newark rocks in the Acadian area exhibit a monoclinal structure, with a prevailing northwesterly dip, interrupted by broad, low folds. The monocline is broken by numerous faults with a small displacement and by occasional faults with a displacement of hundreds of feet. The other areas of Newark rocks have undergone deformation of a similar nature, but the direction of the monoclinal tilting differs in the various areas. In the case of the Connecticut Valley, the Pomperaug Valley (Connecticut), the Deep River (North Carolina), and the Wadesborough (North Carolina) areas, the dip is southeast, where as in all the other areas it is northwest.

The two structural features, the folds and faults, will be treated separately and finally some attention will be given to the theories of origin of this structure.

FOLDS

The most important and the most conspicuous fold in the Acadian area is that shown by the hook in North Mountain which incloses Scots Bay. The point of the hook forms Cape Split, and the back of the hook, Cape Blomidon. This syncline pitches down on the north side and is cut off on the north by a fault shown in cross-section DD, Fig. 28. The syncline is shown principally in the North Mountain basalt which dips toward Scots Bay on all sides of the Bay at angles of about 5°. Under the basalt flows the Blomidon shale is seen following the erosional escarpment, on the south side of North Mountain, around to Cape Blomidon, near which point it disappears under the waters of Minas Basin, as

shown in Fig. 27. Above the North Mountain basalt comes the Scots Bay formation, the youngest formation in the Newark group of the Acadian area. The Scots Bay formation is exposed on the south side of the Bay, as shown in Fig. 27.

The eastern extremity of Minas Basin, east of Economy Point (the area shown in Fig. 23), also forms a syncline which has been disturbed by faulting at various points. The beds of red sandstone on either side of Cobequid Bay dip toward the bay at angles of about $3°-5°$ except where they have been tilted by faulting. This gentle dip must simulate that of the strata when they were first deposited in the slowly subsiding geosyncline.

A syncline, which is well shown in a shore section, is found at Quaco, between West Quaco and Melvin's Beach, on the north side of the Bay of Fundy (see cross-section BB, Fig. 7). The sediments of the Quaco section are readily identified by the Quaco conglomerate in the center. This conglomerate is exposed on the shore near Vaughan Creek with a dip of $30°$ to the north and again a mile inland (northwest) with a corresponding dip to the south. The syncline is cut off obliquely on the north by a fault in such a way that the axis of the syncline is shown in the shore section near Melvin's Beach, but the Quaco conglomerate of the northern limb does not reappear.

At Split Rock a low anticline is shown, at Martin Head a syncline, and at Waterside an anticline and the adjoining syncline. In each of these cases the folds are cut off by faults. The folds are at a low angle with broad arches or troughs.

Cape d'Or shows a small syncline in the basalt flows where the basalt ridge turns, from its east-west course, to make the Cape on the south. Horseshoe Cove has been formed at the axis of the syncline. The basalt is also faulted as is shown in Fig. 12.

Everywhere in the sea-cliff exposures there are minor flexures in the Acadian Triassic, both in the sediments and in the igneous rocks. In Fig. 19, an example of the folds in the sediments west of Five Islands is given. In the North Mountain basalt, gentle folds are shown at Scots Bay, where the Scots Bay formation is preserved in synclines (Fig. 29), and at Digby Gut, where a long syncline is shown at Victoria Beach.

FAULTS

The disturbance at the close of the Newark sedimentation threw the rocks of this group into fault-blocks with a monoclinal tilting toward the northwest. With such a structure, the major faults would tend to assume a northeast-southwest trend, and some of the more important faults should bound the formation on the north and northwest.

The faults at the margin of the Triassic area are confined to the northern and western sides. Thus the basalts of Grand Manan are faulted down on the west side, while the pre-Triassic rocks on the east side of the island are probably tilted up. The older formations against which the basalts were downthrown have since been eroded away, because they were less resistant than the basalts, and Grand Manan Channel has been formed in them.

The northern and northwestern sides of the Triassic areas at Split Rock, Quaco, Martin Head, and Waterside are all dropped down as fault-blocks against older rocks. At Martin Head the pre-Cambrian rocks form Martin Head itself, which is south of the exposure of the Triassic sediments. This exposure of older strata may be explained either as a horst or as the basement upon which the southern limb of the Triassic syncline rests. The latter view is favored, making the Triassic and the exposure of pre-Cambrian part of one fault-block, with a fault south of the pre-Cambrian. There also appears to be a minor fault in the axis of the Martin Head syncline.

The fault of greatest displacement in the Fundy region is the Cobequid fault (shown on the general map of the region), which stretches from West Advocate, north of Cape d'Or, to a point northeast of Truro, a distance of 90 miles. On the north side of the fault is the Cobequid group of sedimentary and igneous rocks which composes the Cobequid Mountains. On the south side of the fault are Triassic sandstones at West Advocate and Advocate Harbour, and Pennsylvanian rocks east of Advocate Harbour. The displacement of this fault is probably 2,000–3,000 feet.

South of the Cobequid fault is another east-west fault which bounds the Triassic on the north from Cape Sharp to the Chiganois River (northeast of Truro). The displacement of this fault appears

to be greatest on the west, with a downthrow of 1,500 feet or less. Parallel to this fault is another at Clarke Head which has brought the Triassic down on the north against older rocks on the south, forming a small graben shown in Fig. 17. All the rocks at Clarke Head are intensely faulted.

The remnants of North Mountain basalt at Cape Sharp and at Partridge Island appear to be faulted off on the south side. The throw of this fault is uncertain in direction, but it may be a continuation of the southernmost fault at Clarke Head.

The exposure of North Mountain basalt at Cape d'Or exhibits several faults in a north-south direction, as shown in Fig. 12. The end of Cape d'Or is probably on an east-west fault line. This same fault may extend eastward.

The Five Islands region exhibits complex block-tilting with blocks of relatively small size. Besides the fault bounding the Triassic on the north, and the Cobequid fault farther north, an east-west fault is shown at Gerrish Mountain (Figs. 20, 22). The Five Islands are each separated by faults and are each tilted in different directions. These faults on the north become lost in a greatly slickensided region shown in detail in Fig. 21. The slickensided surfaces are usually vertical and have a north-south direction. The major movement appears to have been in a horizontal plane, but the stratification shows that there also has been vertical movement. Many other north-south faults are shown along the shore from Clarke Head to Five Islands, and a typical section is shown in Fig. 19.

Near Lower Economy a strike (east-west) fault brings the Triassic down into contact with a mass of Pennsylvanian strata on the north on which the Triassic rests unconformably.

The hook of North Mountain, at Cape Split, is cut off by a northeast-southwest fault which gradually cuts across this limb of the Scots Bay syncline.

North Mountain is composed of basalt flows tilted to the northwest so that an erosion escarpment is produced on the south side of the mountain and a gentle dip-slope on the north side. The sea-cliffs on the north side are never very high for this reason. With a continuation of the dip-slope, the erosion top of the flows

appears to extend under the Bay of Fundy. The coast charts do
not show any pronounced submarine ridges parallel to North
Mountain, such as some authors have referred to, and therefore
there is a lack of evidence of any major fault parallel to North
Mountain. Moreover, no geological structure under the Bay of
Fundy appears to be deducible from the submarine topography.

Cross-faults in North Mountain are readily shown by offsets
in the ridge of basalt flows because the flows are dipping at a low
angle northwest. The offsets are at Digby Gut, Bay View, Gulli-
ver's Cove, Petit Passage, Grand Passage, and southwest of Brier
Island. The line of these faults is north-south. The displacement
of the flows by these faults, with the exception of the first and last
faults, is to the north on the west side of the fault. These offsets
are shown on the accompanying general map of the region. The
offset at Digby Gut is shown on Fig. 30, and that southwest of
Brier Island is shown by the position of a short submarine ridge
on the coast chart.

As shown by Daly[1] and by Haycock,[2] these fault lines across
North Mountain, and also the depressions at Parker Cove and
Sandy Cove were occupied by rivers at the time that the Summit
peneplain was being developed over the region. When the pene-
plain was uplifted the rivers became rejuvenated and persisted in
their courses until the present valleys were cut. Headward erosion
up the valley which is now St. Mary's Bay diverted the streams
flowing across the basalt south of Bay View, and the more rapid
erosion in Digby Gut caused the abandonment of the Bay View and
Parker Cove valleys.

<div style="text-align:center">THEORIES OF ORIGIN</div>

The faults which traverse the rocks of the Newark group are of
deep-seated origin, extending into the older formations. The
character of the underlying formations varies with the different
areas. Thus the Acadian Triassic is underlain in part by Carbonif-
erous folded sediments, in part by Silurian and Devonian slates and

[1] R. A. Daly, "The Physiography of Acadia," *Bull. Mus. Comp. Zoöl., Harvard
College*, XXXVIII (1901), 92.

[2] E. Haycock, "Records of Post-Triassic Changes in Kings County, Nova Scotia,"
Trans. N.S. Inst. Sci., X (1900), 297.

Devonian granite, and in part by pre-Cambrian slates (the Meguma series) and other metamorphic rocks (the pre-Cambrian complex of New Brunswick). The Connecticut Valley area is underlain by gneisses and schists, the New Jersey area by gneisses and some Paleozoic sediments, and the Richmond area by gneisses and granites. A theory which accounts for the structure of the Newark beds must therefore suit the various basement rocks.

Davis,[1] in studying the Connecticut area, reached the conclusion that the origin of the monoclinal fault structure was the slipping of blocks of the underlying crystalline rocks on each other along cleavage planes. As pointed out above, although the Connecticut area is underlain by gneisses and schists, the other Newark areas are not. Suitable cleavage planes would therefore not be expected in the other areas.

In the Minas Basin region, the crystalline rocks are several thousand feet below the base of the Triassic. Furthermore, the planes of slipping in these crystallines are parallel to the main structural lines of the formation. These lines run at an angle to the axis of Minas Basin, as is seen in the nearest exposures of the crystallines (the Meguma, or Gold-bearing series). The theory proposed by Professor Davis does not seem, therefore, to apply to the Acadian area.

Hobbs[2] considers that Professor Davis' theory does not suit the facts in the Connecticut Valley or in the Pomperaug area. For the latter area, Hobbs proposes another theory to account for the peculiar system of quadrangular block-faults. As this detailed faulting is not typical of all the Newark areas, the theory is of limited application.

Professor Barrell[3] has recently ascribed the origin of the Connecticut Valley Triassic area to the gradual development of a fault on the east side of the geosyncline, contemporaneously with the

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[1] W. M. Davis, "The Structure of the Triassic Formation of the Connecticut Valley," *U.S. Geol. Surv., 7th Ann. Rept.*, 1888, pp. 486–89.

[2] W. H. Hobbs, "The Newark System in the Pomperaug Valley, Connecticut," *U.S. Geol. Surv., 21st Ann. Rept.*, Part 3 (1901), pp. 122–33.

[3] J. Barrell, "Central Connecticut in the Geologic Past," *Proc. Wyo. (Penn.) Hist. and Geol. Soc.*, XII (1912).

filling of the basin with sediments. This fault is supposed to have been initiated after sedimentation commenced, and to have increased in displacement with the accumulation of the sediments.

In the Acadian area a corresponding fault is found on the north and west, but there is no evidence that this fault developed until sedimentation ceased. No completely satisfactory theory to account for the structure has yet been presented.

IGNEOUS ROCKS

DISTRIBUTION

A description of the igneous rocks in each locality has been given in the description of the general stratigraphy of the region, and therefore merely a summary is attempted here. The flows at Cape d'Or have been especially studied, and will be considered in a separate paper by Professor Alfred C. Lane and the writer.

All of the igneous rocks associated with the Acadian Triassic are of a basaltic composition. From the form of occurrence, they are grouped into dikes and flows. According to the time of formation, they are classified as the Five Islands volcanics and the North Mountain basalts. Dikes are so rarely exposed that it is necessary to consider the rocks from the point of age, rather than form.

In Nova Scotia, outside of the Triassic area there are some diabases and basalts which are probably of Triassic age. At Cheverie, near the Avon River, there is a sill of diabase intruding Pennsylvanian strata.[1] Again, in Guysborough County, near Guysborough, Fletcher has mapped on the sheets of the Geological Survey of Canada masses of diabase cutting the Union-Riversdale series. The nature of these masses is described by Fletcher[2] as partly amygdaloidal, partly dioritic.

Dikes of Triassic age occur in a number of places between Nova Scotia and the Connecticut Valley. The large majority of them are of diabase composition.

[1] Verbal communication from Mr. W. A. Bell, of the Geological Survey of Canada.

[2] H. Fletcher, Geol. Surv. of Canada, Annual Report, 1886, pp. 101-3 P; also Geol. Surv. Canada, Maps, Nova Scotia, Nos. 30, 31, 35, 36.

Under the heading Five Islands volcanics are included the tuffs, agglomerates, and basalt flows in the vicinity of Swan Creek and the Five Islands. The thickness of the volcanics is estimated as at least 350–400 feet. One associated dike is exposed at Gerrish Mountain.

The Gerrish Mountain diabase dike is almost vertical and about 20 feet or more in thickness. The diabase shows marked columnar jointing, the columns being rather short and largely horizontal or dipping at a low angle to the horizontal. The dike is connected with the basalt flow which caps the sandstones of Gerrish Mountain, and it has evidently furnished the material for this flow and perhaps for a large part of the other igneous rocks for the vicinity.

The basalt flows associated with the Five Islands volcanics are found at Gerrish Mountain, on four of the Five Islands, on Two Islands, and at Portapique Mountain (east of Gerrish Mountain). It is noteworthy that the relation of these flows to the agglomerates is unknown, and that there is no proof that they are not connected with the North Mountain basalt instead of with the Five Islands volcanics. The structure of these flows is in large part columnar, and the base and the top of each individual flow is marked by amygdaloid. The basalts are the usual fine-grained, dark-gray, heavy rocks composed of augite and plagioclase with accessory amounts of magnetite and occasionally olivine. A more detailed petrographical description will be given below for the North Mountain basalt, which will apply equally well to these flows.

Only one flow is exposed in Gerrish Mountain. This has a thickness of over 75 feet. Three flows are exposed on the north side of Moose Island, the upper one being agglomeratic. A portion of a single flow is exposed on Diamond Island and on Long Island. Two flows are seen on Pinnacle Island. The northern of the Two Islands consists of three flows, the southern of probably only one.

The base of the series of flows is exposed on the eastern side of Moose Island and on Gerrish Mountain. Under the amygdaloid which marks the base of the flow is a layer of green ash 2–3 feet in

thickness.   A similar ash-bed is exposed west of Swan Creek under
the agglomerate flow mentioned below.   The thickness of the flows
on Gerrish Mountain may be considerable, as the basalt covers
a large area.

The agglomerate beds, with associated tuffs, are exposed from
Greenhill eastward to Five Islands, in disconnected areas.   The
relation of these remnants of flows and volcanic ejectamenta to
the sandstones is a problem only partly solved because of the faulted
contacts, with possibly minor thrust-faults, and the landslides which
are especially abundant in the tuff.   The tuff underlies the agglom-
erate in most cases.   The thickness of the tuff varies from a few feet
to 50 feet, and that of the agglomerate flows from 20 to 150 feet or
more.   Exposures show that the agglomerate is overlain by red
sandstone, and is therefore older than the North Mountain basalt.

The agglomerates consist of a mass of angular fragments 'of
basalt and amygdaloid in a dark-green matrix of a basaltic com-
position.   The exact character of the matrix is difficult to determine
because it is everywhere so badly weathered that a solid specimen
could not be procured.   The field evidence, however, indicates that
this matrix is in part tuffaceous and in part a normal basalt.   At
the sides of some of the masses of agglomerate are blocks of angular
basalt and amygdaloid imbedded in a red sandstone matrix, showing
that the breccia was either blown out into the area where sandstone
was being deposited, or washed out from a bed of tuff and breccia.
The cross-cutting contacts at one side of the masses of agglomerate
in two instances give them the appearance of intrusive bodies
rather than of flows.   If the agglomerates are intrusive, rather
than extrusive, they probably fill volcanic necks.

NORTH MOUNTAIN BASALT

Under the term North Mountain basalt, used in a generic sense,
are included the basalt flows of Grand Manan, Isle Haute, Cape
d'Or, Cape Sharp, Partridge Island, and North Mountain.   The
series of flows at these localities are correlated either for structural
reasons or because they are underlain by shale correlated with the
Blomidon shale.

In each locality there are several flows, indicating successive extrusions within such a short time of each other that no sediments were deposited between the flows. It is impossible to state whether any single flow originally covered the geographical area over which the remaining exposures indicate that the formation once extended. The Palisade diabase formes one sill 100 miles long on the outcroping edge, while North Mountain is 120 miles long. In the former case the igneous material was intruded at some distance below the surface and had to push up this great weight of rock, which, however, acted as a blanket over the feeder. In the latter case the igneous material was extruded at the surface, with no roof to sustain, but the feeders were constantly subjected to the great heat loss by radiation at the surface, which would tend to freeze them up.

Dikes associated with the North Mountain basalt are rare. Several were reported on Grand Manan by Bailey,[1] but they were not observed by the writer. The largest of these is 50 feet wide, and occurs at Flag Cove, near Swallow-Tail Light.

Other narrow dikes occur on the south side of Scots Bay, just east of the Scots Bay formation exposures. These dikes cut the basalt within 25 feet of the top of the upper flow. From the other exposures of this flow it is judged to be at least 100 feet thick, and, if so, it is quite evident that the dikes cut the upper flow and are not the feeders. With the dikes are many fissures filled with vein material which is seen under the microscope to consist largely of silica stained red with hematite. The width of both the veins and the dikes varies from one to ten inches, and in the field they look very much alike.

In thin-section the dikes are seen to consist of a very fine-grained diabase, greatly altered and stained with limonite. The rock is similar to that of the flows near the center, but shows some glass.

From the field evidence of the dikes and veins side by side in the upper part of this thick flow, and from the microscopic evidence, it is concluded that the dikes were formed from the basalt of the upper flow after the crust of the flow had solidified and while the

[1] L. W. Bailey, *Geol. Surv. Canada, Report of Progress*, 1870, pp. 216–21.

center of the flow was still liquid. The crust appears to have become fissured, with some of the fissures reaching down to the still molten rock, and other of the fissures having no great depth and therefore being filled with quartz from above at a later stage.

The structure of the flows is similar to that of all basalt flows. The individual sheets are clearly distinguished by a relatively thin amygdaloidal base and a relatively thick amygdaloidal top. Flows composed entirely of amygdaloid were observed only at Cape d'Or. The basalt is closely jointed and columnar joining is frequently developed. The angle at which the columns and planes between the sets of columns stand with respect to the vertical and horizontal, respectively, indicates the dip of the flow. Faulting in the sheets is frequently obscured by jointing.

In North Mountain, from Cape Blomidon to Cape Split, and along the Victoria Beach shore of Digby Gut, the thickness of the flows may be estimated. A partial section is exposed at Sandy Cove and at Freeport, on Long Island, and at Tiverton, on Brier Island. In most of the sections the lowest flow is the thickest, and at the top of the series are several thin flows.

The section from Cape Blomidon to Cape Split shows two and probably three flows, each with an estimated thickness of 150–300 feet. The top of the upper flow is exposed around the edge of Scots Bay. It exhibits the small folds into which all the basalt flows have been thrown. No other sections of the North Mountain basalt are exposed until Digby Gut is reached, because the sea-cliffs are low and expose only the upper flow or flows.

At Victoria Beach the best section is found. There is some doubt if the lower flow, as here estimated, is not composed of two separate flows, but the microscopic examination of slides made from the first exposures above and below the blank in the section indicates a coarseness of grain which characterizes the center of a thick flow. Erosion has probably removed several flows from the top of the section. The section consists of:

> Top. Six flows 2–45 feet in thickness......160± feet
> Base. Main flow ....600+   "

The upper flows of the Victoria Beach section are absent from the exposures at the end of Digby Neck. They have either been

removed by erosion or were never deposited there. The thicknesses of the portions of the flows remaining between the waters of St. Mary's Bay on one side and the Bay of Fundy on the other are estimated as:

	Sandy Cove	Tiverton
Upper flow	300± feet	150+ feet
Lower flow	150± "	75+ "

On Grand Manan the section is quite similar to those given above. The number of thin flows on the top of the series was not counted accurately. The section is:

Top.	Ten(?) thin flows averaging 10–15 feet in thickness	100 feet
	Second flow	250 "
Base.	First flow	450 "

The number of flows exposed on Isle Haute is unknown. The section at Cape d'Or consists of 5 flows, of which the lower one (556 feet) is the thicker. At Cape Sharp and at Partridge Island two flows appear to be shown.

Only one petrographic description of the basalt of North Mountain has been published.[1] On account of the similarity of the basalts associated with the Newark group little attention has been paid to those of the Acadian area.

The basalt is a dark-gray or dark-greenish fine-grained rock composed of plagioclase feldspar and augite with accessory amounts of magnetite, olivine, and glass. The feldspar is a labradorite, varying slightly in composition. The texture of the rock is ophitic, laths of feldspar inclosing augites, or masses of augite inclosing small feldspar laths. Chlorite, magnetite, limonite, hematite, and serpentine are present as alteration products.

The proportion of glass to crystalline matter, of labradorite to augite, and the presence of olivine each depend on the proximity of the section to the top or bottom of the flow. The top of the flow is always quickly chilled in contact with the atmosphere, and solidifies with a large amount of glass and a large number of gas cavities. These cavities later become filled with quartz, calcite,

[1] V. F. Marsters, "Triassic Traps of Nova Scotia," *Am. Geol.*, V (1890), 140–43.

or some other mineral to form amygdules. At the base of the flow, rapid chilling also takes place; less glass is developed, but well-crystallized magnetite is found. Alteration, however, soon commences in the base of the flow because of the reaction of heated waters on the basalt.

The glass, characteristic of the top and the bottom of a flow, frequently contains most of the feldspar in laths already formed, showing that the feldspar had commenced to crystallize before the augite. In other cases the glass is accompanied by both augite and feldspar. The glass always has a cloudy appearance.

Gravitative adjustment takes place in all flows which are sufficiently thick, and which remain hot sufficiently long for a movement of the crystallizing magma to take place without being recorded in flow structure. As in the case of the Palisade sill, olivine tends to form near the base of the flow and in the quickly chilled top.

Gravitative differentiation is also shown in the relations of the labradorite to augite. The augite settles toward the base of a flow as in the case of a sill, and the feldspar rises.

The chemistry of the Cape d'Or flows will be treated in a separate paper, but it may be stated here that those basalts show a normal composition, averaging about 52.5 per cent silicia, 14.3 per cent alumina, 9.8 per cent lime, 2.5 per cent soda, and 1 per cent potash.

Rosiwal measurements on thin sections from the center of a 556-foot flow show a mineralogical composition of 40 per cent plagioclase feldspar, 56.5 per cent augite, and 3.5 per cent iron ores.

All the basalts show more or less alteration and disintegration except where rapid marine erosion exposes fresh rock. The amygdaloid, even where fresh, is always altered. In the drill-cores at Cape d'Or, the same character of alteration was shown in each amygdaloidal layer. A certain amount of hematite, with limonite, is developed, giving these rocks a reddish color.

Veins are very common in the dense basalts as well as in the amygdaloids. The veins are formed of jasper or quartz, with either reddish (hematite) or greenish (malachite or chlorite) walls.

ORIGIN

The basalt unconformity of the Acadian Triassic always shows upturned and beveled rocks overlain by Newark sandstones or conglomerates with bedding parallel to the underlying erosion surface. This fact indicates that the Newark sediments were deposited on a peneplain, as has been found the case in the Connecticut[1] and Richmond[2] areas.

On this peneplain, an orographic basin was formed, and into the geosynclinal area sediments were brought from all sides. An equilibrium between the rate of sedimentation and of subsidence of the geosyncline appears to have been reached when the Blomidon shales were deposited at the top of the Annapolis formation.

The Wolfville sandstone at the base of the Acadian Newark shows red sandstones and occasional conglomerates and shales, in general evenly bedded. The pebbles in the conglomerates are stream-worn, but are frequently subangular. The character of the Quaco conglomerate has been sufficiently treated. The Wolfville sandstone indicates stream transportation, with deposition in flood-plains, and perhaps in past in broad alluvial fans.

The Blomidon shales are generally evenly bedded, but show occasional ripple or current marks, and rarely mud cracks. The presence of *Estheria* indicates temporary bodies of water. Flood-plains of mature rivers would furnish the necessary conditions for the deposition of shales, with cut-off lakes in which the crustaceans could live.

The red color of the Annapolis formation evidences long oxidation of the iron during transportation and deposition.[3] The white or gray color indicates a lack of hematite, and the green color is caused by the presence of chlorite.

The climate during the deposition of the Annapolis formation was apparently hot and dry, with occasional floods. The presence of calcite in nearly all the sediments, and the scarcity of arkose,

[1] W. M. Davis, *U.S. Geol. Surv.*, *18th Ann. Rept.*, 1898, p. 20.

[2] N. S. Shaler and J. B. Woodworth, *U.S. Geol. Surv.*, *19th Ann. Rept.*, 1899, p. 408.

[3] J. Barrell, "Relation between Climatic and Terrestrial Deposits," *Jour. Geol.*, XVI (1908), 159–90, 255–95, 363–84.

and of plant and animal remains, all favor long oxidation of the sediments in a dry tropical climate.

The Scots Bay formation was deposited in part, at least, in a lake, because fish remains occur in the strata. This lake came into existence soon after the extrusion of the North Mountain basal flows, as is indicated by the lack of erosion in the upper amygdaloid.

The Five Islands volcanics are interpreted as representing a phase of igneous activity slightly earlier than that in which the North Mountain basalt flows were extruded. The volcanics may have come from central vents as well as from fissure eruptions.

The North Mountain basalt must have come from fissure eruptions, and spread out over a large portion of the Triassic geosyncline, as is indicated by the widely separated areas at North Mountain and at Grand Manan. The geographical extent of any individual flow is impossible to determine, but it appears that the earliest flow, or series of flows, was the thickest.

The physiographic conditions accompanying the formation of the Five Islands volcanics and the North Mountain basalts are poorly shown. The base of the North Mountain basalt is exposed only on Grand Manan, and there it is greatly weathered. No evidence of contemporaneous lakes over which the lava flowed has been found.